Charge! Electricity and Magnetism

What is Charge?

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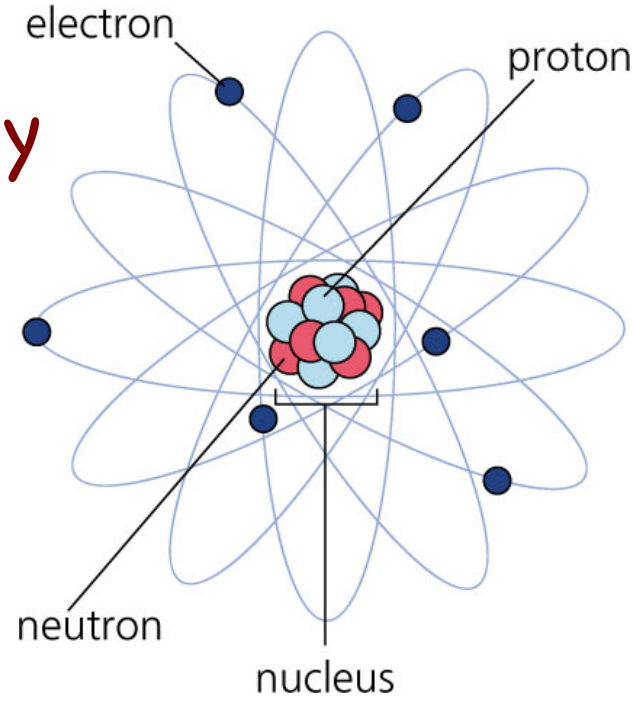
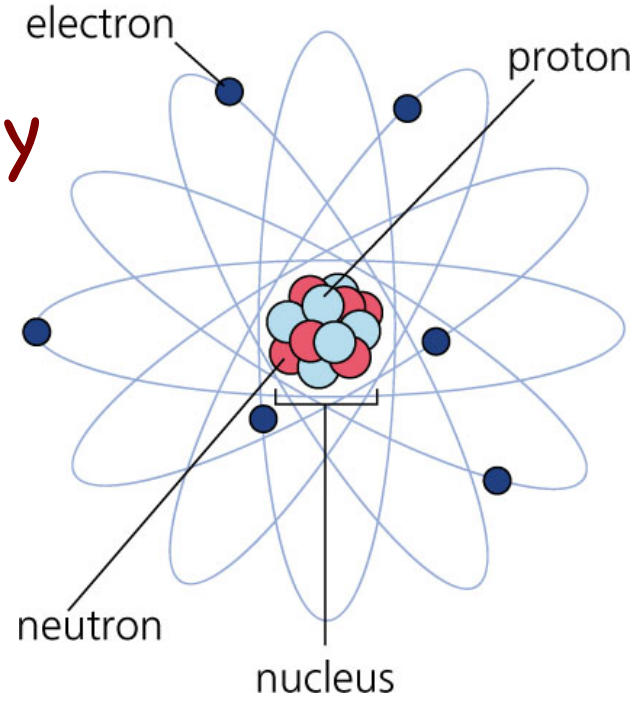
- When atoms don't have as many electrons as they do protons, they carry a charge!

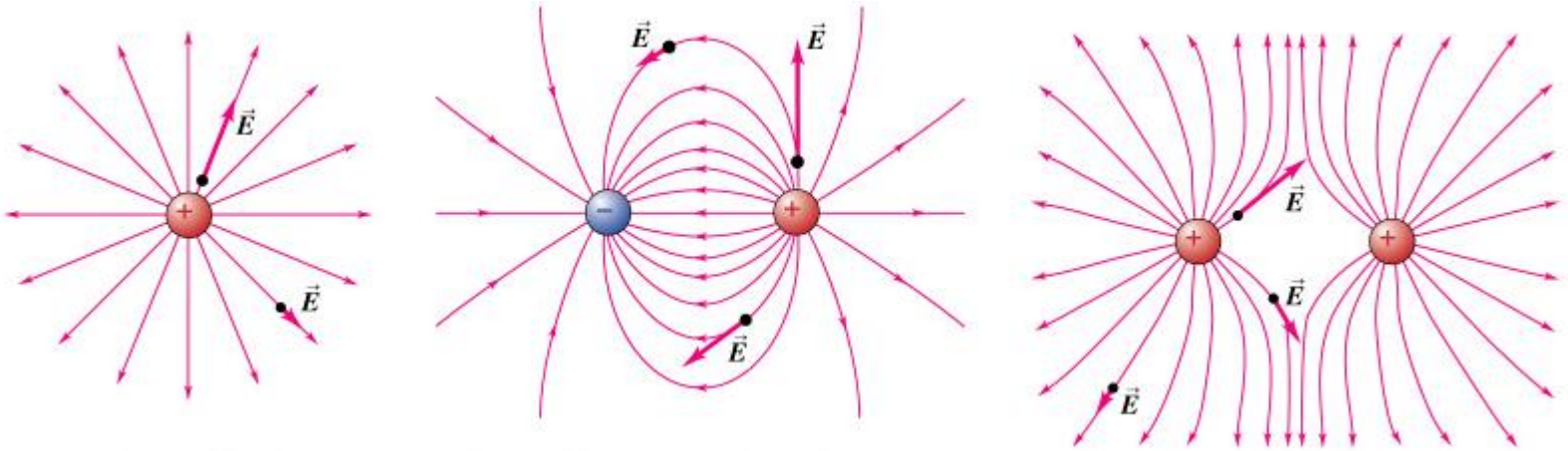
- How do they ACT?



What is Charge?

- When atoms don't have as many electrons as they do protons, they carry a charge!
- Opposite charges attract
- Like charges repel





Where have YOU seen charge?

- "Stuck" charges are also called "Static Electricity"...
- Everyday examples are:
  - ?
  - ?
  - ?
  - ?

Where have YOU seen charge?

- "Stuck" charges are also called "Static Electricity"...
- Everyday examples are:
  - Socks in the dryer
  - Walking around in your socks on carpet
  - Getting out of the car in winter
  - Lightening!

Charge in Action!

- We need some volunteers!
- We have some balloons and some string…
  - Can you show us how like charges repel?
  - How can you test for charge? (Electroscope!)
- We also have some wool and plastic…
  - What things get attracted to a static charge?
  - Are you surprised at what does & does not?

Balloon Demo

Electricity is Moving Charge!

- How can we make charges move?

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- We need a volunteer!
  - We have some lemons, copper, zinc and a clock
  - Can you make the clock work?

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- This is a chemical generator!
  - What are some other examples of chemicals creating electricity?

Batteries!

More ways to make electricity...

- Not all of our electricity comes from batteries...
- We need another volunteer!
  - We want to light a light bulb...

More ways to make electricity...

- Not all of our electricity comes from batteries...
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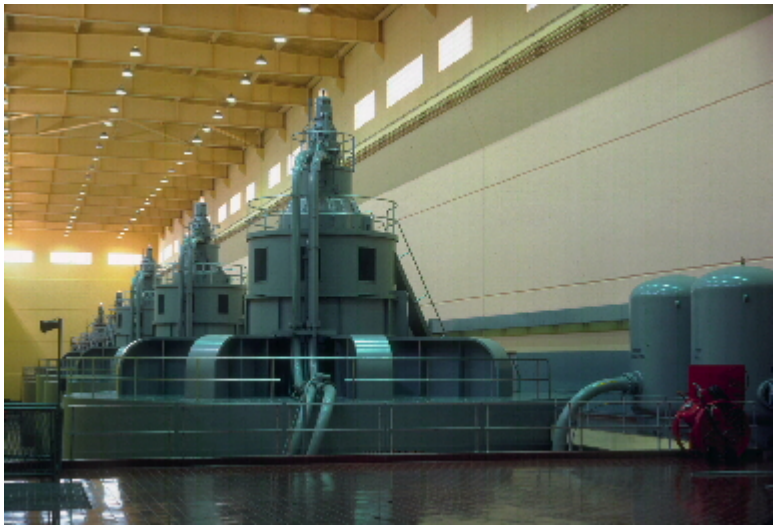
  - We want to light a light bulb...
- This is a mechanical generator
  - What other mechanical generators can you think of?

Power Plants!



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- Electricity needs to flow from high voltage to low voltage
  - Moving electricity is called CURRENT
  - A lot of current can be dangerous!
- If there's a break in a circuit, current won't flow!
  - There are "open," "closed" and "short" circuits
  - Help us make some circuits!

More about Circuits...

- There is a special relationship between voltage, resistance and current!

Simple Circuit Demo

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- There is a special relationship between voltage, resistance and current!

Simple Circuit Demo

- How fast do electrons and electricity really move?

Electrons and Electric Signals

Magnetism

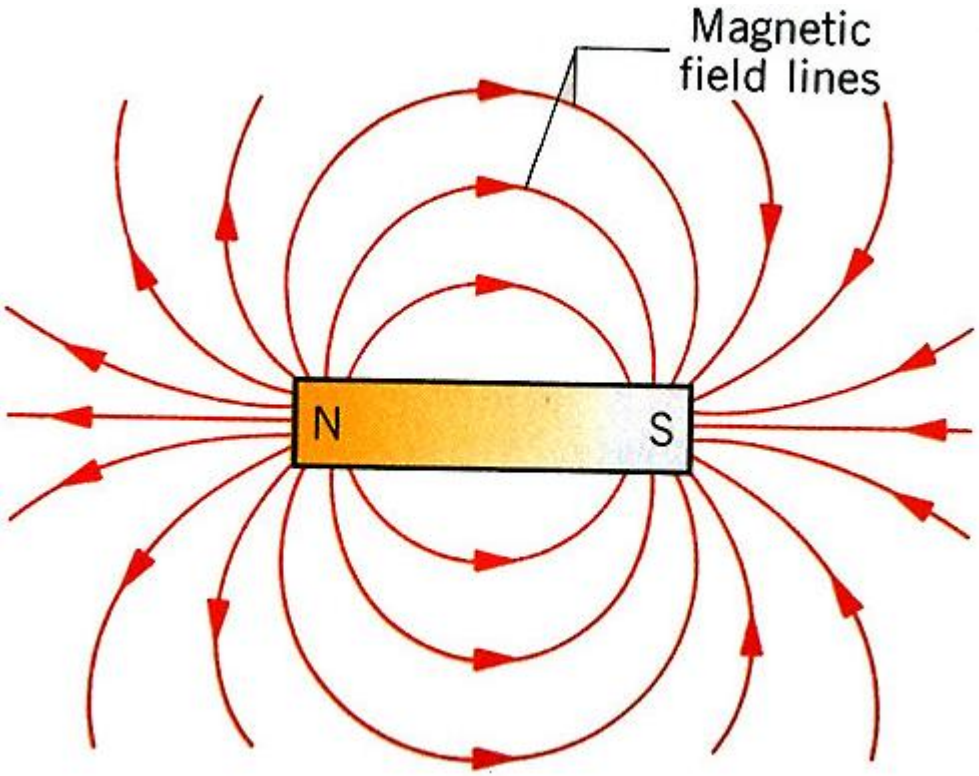
- What is a magnet?
  - How does it act?
  - What kinds have you seen?
  - What happens to non-magnets around magnets?

Magnetism

- What is a magnet?
  - How does it act?
  - What kinds have you seen?
  - What happens to non-magnets around magnets?
- We need another volunteer!
  - What can you pick up with a magnet?
    - Is it the same as we picked up with a static charge?
    - Do magnets carry a charge?
  - What will the magnetic force go through?

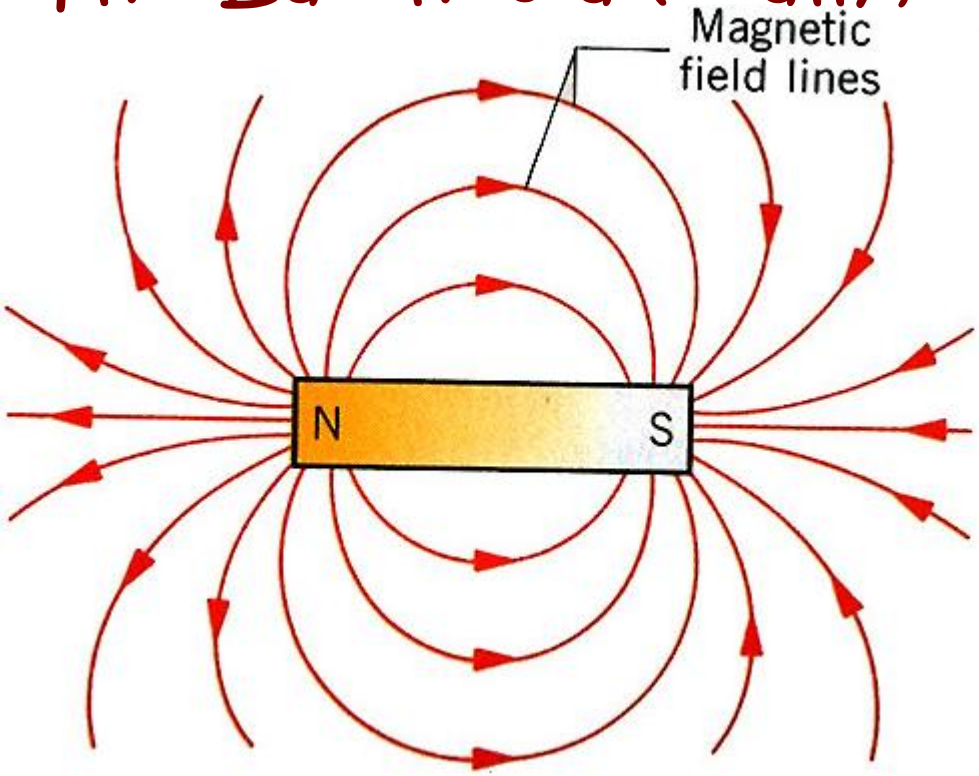
A Compass is a Magnet!

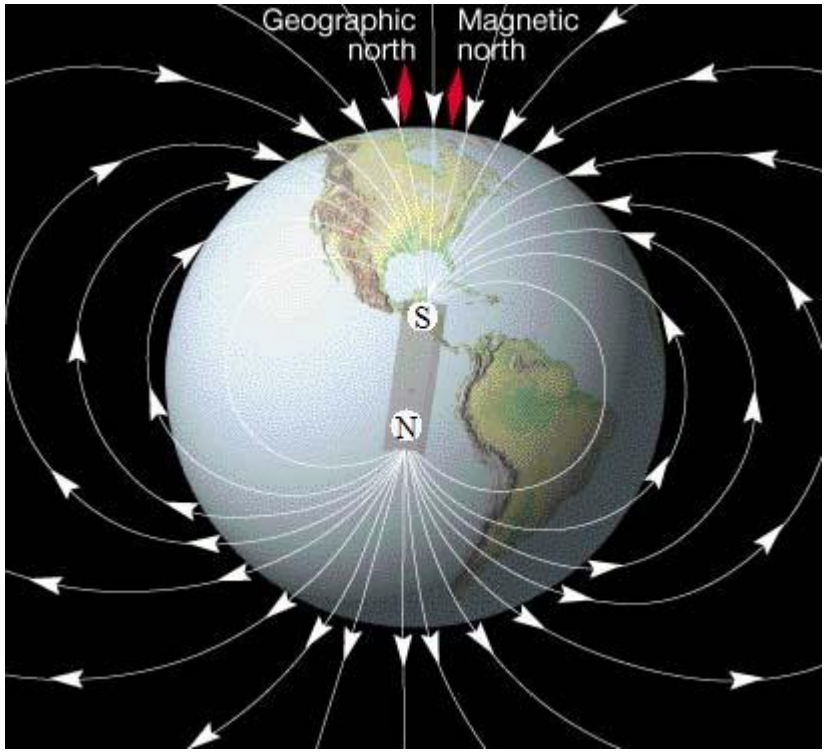
- Compasses align with magnetic field lines
  - What does that imply?



A Compass is a Magnet!

- Compasses align with magnetic field lines
  - What does that imply?
- The Earth is a (really, really big) magnet!





Electricity & Magnetism

- Special things happen when you have a changing magnetic field…

Changing Magnetic Fields

Electricity & Magnetism

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Changing Magnetic Fields

- This is how power plants generate the electricity we use every day!
  - Each type of plant uses something different to turn the magnets:
    - Wind, water, or steam is usually used
    - Coal, natural gas, and fission just make steam!

Magnetism & Electricity ?

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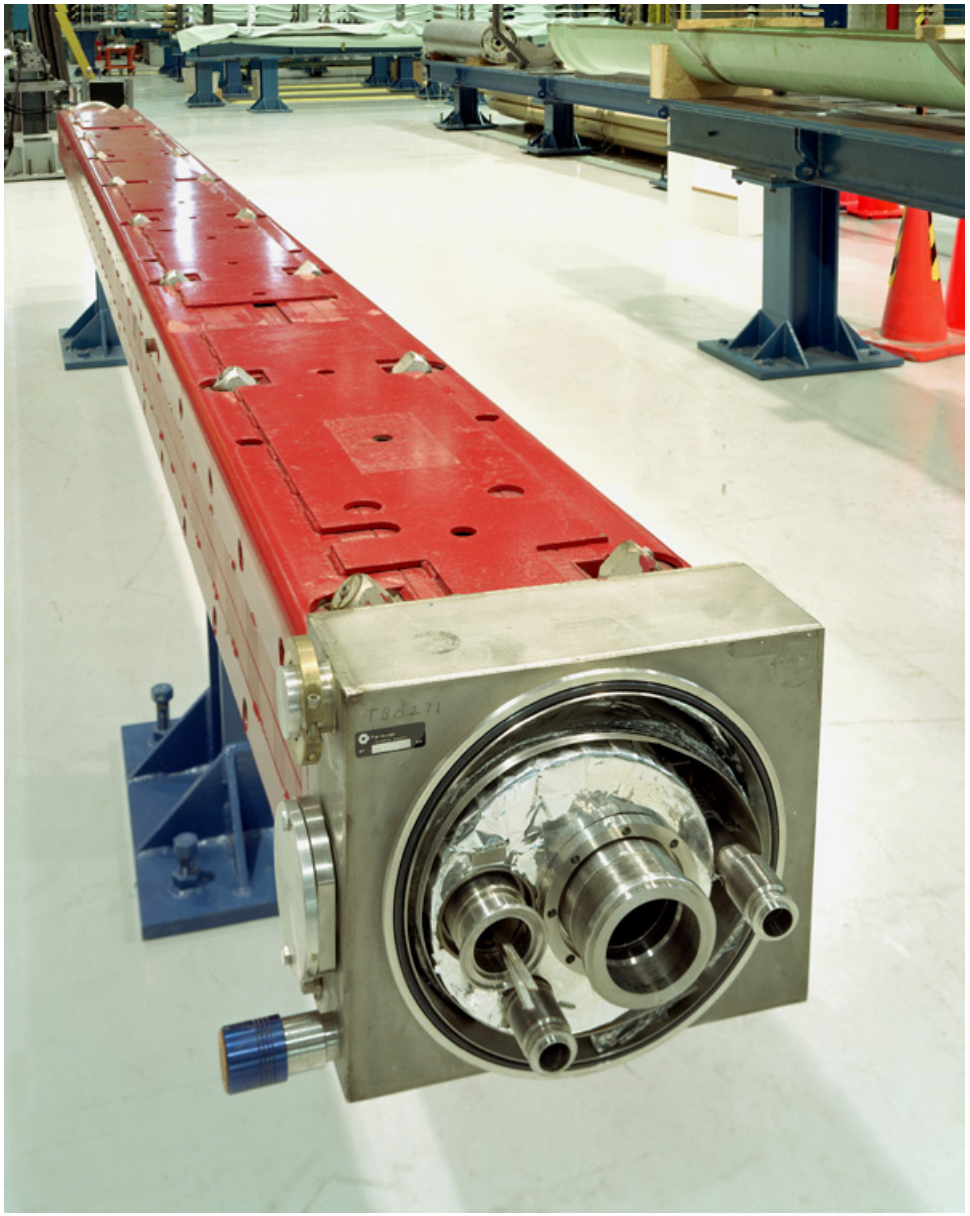
- What other electromagnets have you seen?

Everyday Electromagnets



Faraday and Lenz

- Faraday's Law tells us that a changing magnetic field induces a current
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  - This is what made power plants run!
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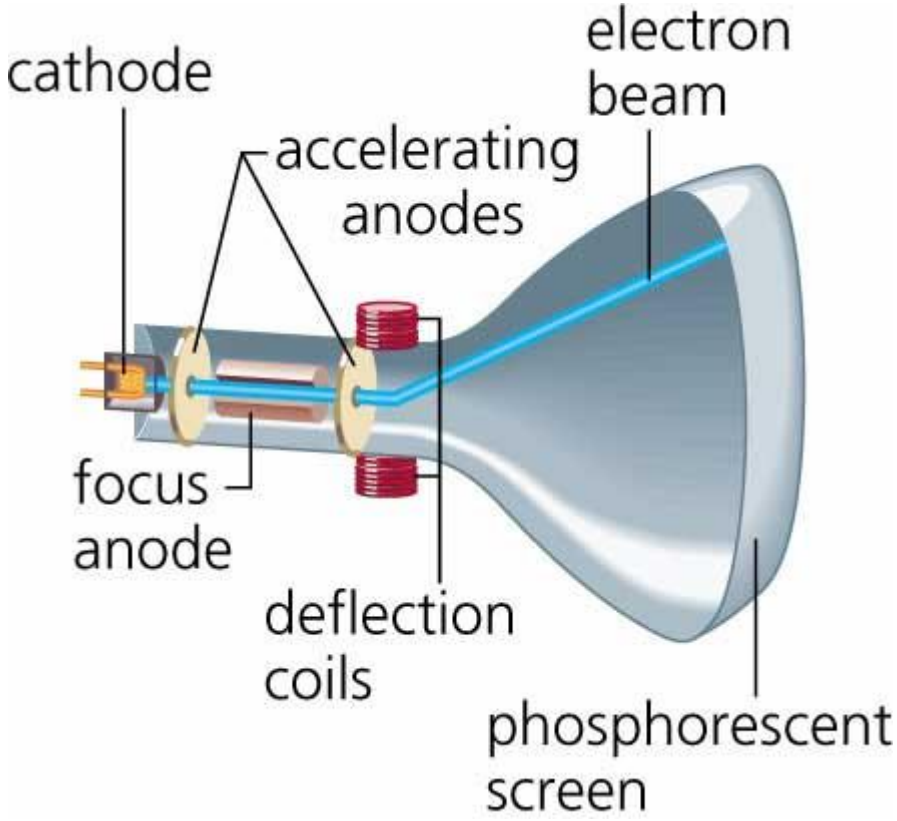
- We need another volunteer!
  - The "induced electromagnet" creates a field that opposes the changing magnetic field!
  - You don't get something for nothing!!

Particle Accelerators at Home!

- Did you know that you probably have a particle accelerator at home right now?

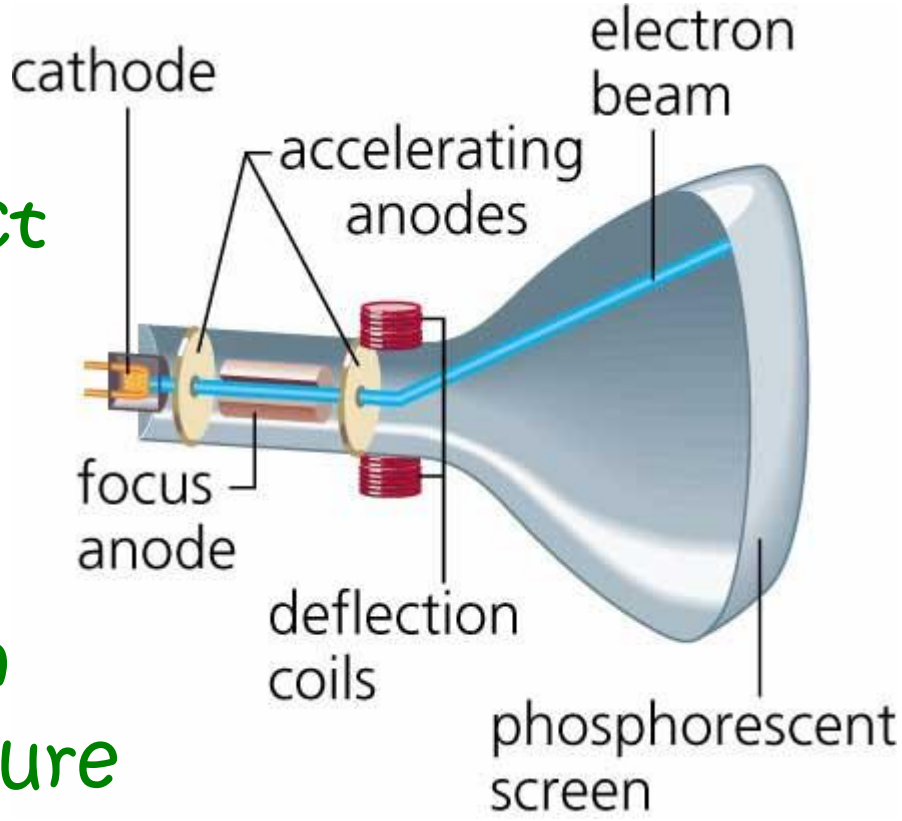
Particle Accelerators at Home!

- Cathode Ray Tubes, the original kind of TVs, are particle accelerators!



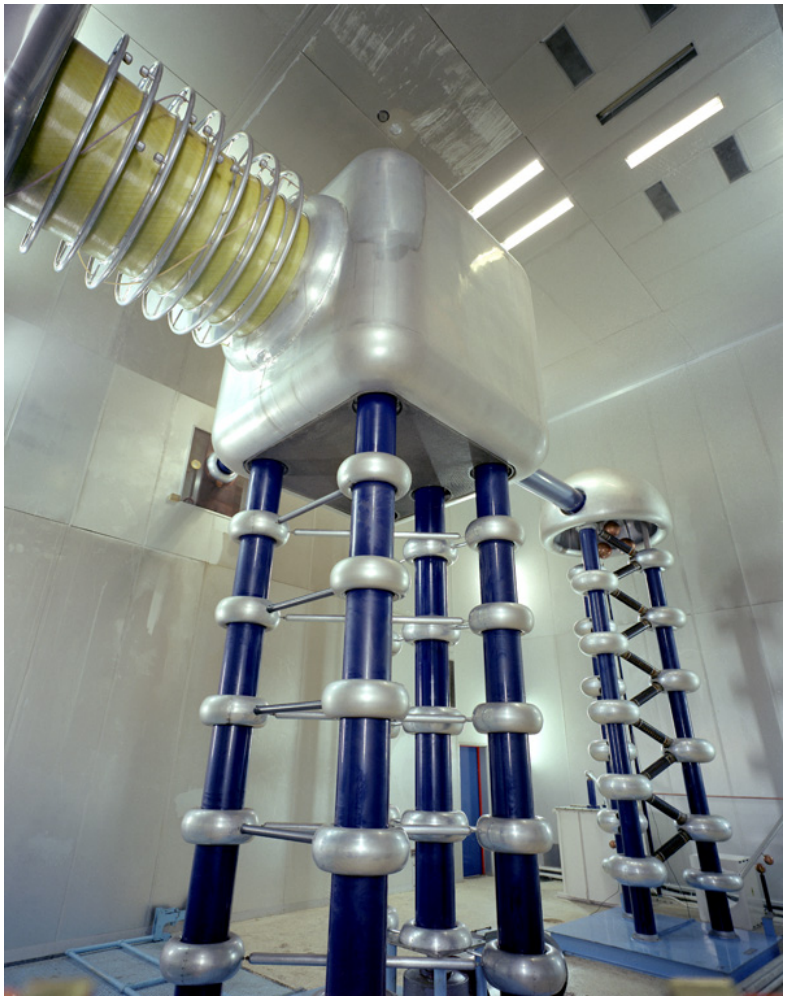
Particle Accelerators at Home!

- Cathode Ray Tubes, the original kind of TVs, are particle accelerators!
- We need a volunteer!
  - Magnets don't just effect other magnets, they also bend moving charge
  - Electromagnets in your TV make a singe electron beam draw a moving picture



Back to Charge...

- A Van de Graaff generator creates a large voltage difference
- We've learned a lot about static and moving charges today...
- Help us guess what will happen when we experiment with the Van de Graaff!



Questions & Answers

- It has been a fun day! Thank you for being such good hosts!!
- Any questions about charge, electricity or magnetism?

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- Any questions about charge, electricity or magnetism?
- Any questions about physics, science, scientists or Fermilab?

Thank You!!!

- Please visit Fermilab anytime!
  - The Lederman Center has lots of activities to help you learn about what we do at Fermilab
  - We have buffalo and prairie trails, too!
- Useful links:
  - Fermilab Education Office: http://www-ed.fnal.gov
  - American Science & Surplus: http://www.sciplus.com/
  - Java Demos: http://www.colorado.edu/physics/phet